DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 05/11/2011 has been entered.

Response to Arguments

Applicant's arguments with respect to claims 1-31, 33-55, 57-72, 75-79 have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 19, 30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The use of trademark names "monel" and "inconel" in claims 19 and 30 render the claims indefinite. If the trademark or trade name is used in a claim as a limitation to identify or describe a particular material or product, the claim does not comply with the requirements of the 35 U.S.C. 112, second paragraph. Ex parte Simpson, 218 USPQ 1020 (Bd. App. 1982). The claim scope is uncertain since the trademark or trade name

cannot be used properly to identify any particular material or product. In fact, the value of a trademark would be lost to the extent that it became descriptive of a product, rather than used as an identification of a source or origin of a product. Thus, the use of a trademark or trade name in a claim to identify or describe a material or product would not only render a claim indefinite, but would also constitute an improper use of the trademark or trade name. MPEP 2173.05(u).

Claim Objections

Claim 42, 46 are objected to because of the following informalities:

Claim 42 is missing a period.

The recitation in claim 46, line 2 of "and a plurality fibers or protrusion" should recite --and a plurality of fibers or protrusions--.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-29, 31, 33-51, 54, 55, 57-59, 62-64, 68, 69-72, 78, 79 are rejected under 35 U.S.C. 103(a) as being unpatentable over TeGrotenhuis et al. (WO 03/078052) in view of Johnston (US 2002/0018739).

TeGrotenhuis teach a process for oxidation (page 27) wherein the reactions are equilibrated to 90% conversion (page 13) and plural fins coated with catalysts (fig. 10, #164), are used in the process (page 26) wherein the multiple microchannels have temperatures around 300°C (page 31). TeGrotenhuis additionally teach or suggest limitations including: another reaction temperature in a second step is lower than the reaction temperature in a first step (page 13), the dimensions of the microchannel (page 9), counter-current relationship of fluid of microchannel with heat-exchange channel (page 15).

TeGrotenhuis fail to teach that an intermediate is formed in a first reaction zone with a first catalyst and a final product is formed in a second reaction zone and that the reaction zones are separated by a non-reactive zone, the first reaction zone and another reaction zone being in the same process microchannel.

Regarding claims 1, 15, 16; Johnston teaches conducting chemical reactions in small scale reactors (para. 0064, 0079, claim 11) wherein different catalysts can be disposed in consecutive reactions with non-reactive zones between the different reaction zones for the purpose of controlling temperature throughout the different stages of the catalytic process (para. 0031, 0072, 0075, 0076).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide different catalysts disposed in the consecutive reaction zones of TeGrotenhuis with non-reactive zones between the different reaction zones in order to control temperature throughout the different stages of the catalytic process (para. 0031, 0072, 0075, 0076) as taught by Johnston.

Regarding claims 1, 3, 13, 14, Johnston teaches conducting chemical reactions in small scale reactors with microchannels (para. 0064, 0079, claim 11) wherein the same catalysts can be disposed in consecutive reactions with non-reactive zones between the different reaction zones for the purpose of controlling temperature throughout the different stages of the catalytic process (para. 0031, 0072, 0075, 0076).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the same catalysts disposed in the consecutive reaction zones of TeGrotenhuis with non-reactive zones between the different reaction zones in order to control temperature throughout the different stages of the catalytic process (para. 0031, 0072, 0075, 0076) as taught by Johnston.

Additionally, it appears that Johnston is silent with respect to whether there is catalyst in the heat exchanger chamber (para. 0072). One of ordinary skill in the art at the time applicant's invention was made would recognize that there is no catalyst present in the heat exchanger zone of Johnston because a catalyst coating is only mentioned regarding the exothermic chamber.

Additionally, it would have been obvious to incorporate these singular elements into an integral reactor. *In re Larson*, 340 F.2d 965, 968, 144 USPQ 347, 349 (CCPA

1965) (A claim to a fluid transporting vehicle was rejected as obvious over a prior art reference which differed from the prior art in claiming a brake drum integral with a clamping means, whereas the brake disc and clamp of the prior art comprise several parts rigidly secured together as a single unit. MPEP 2144.05.

It appears that a 100% approach to equilibrium would be about 50% conversion as an approach to equilibrium would equate to roughly half of the reactants being consumed. As TeGrotenhuis teaches that the processes have generally a 90% conversion rate, it appears that this would be equivalent to an approach to equilibrium of close to 100% and therefore overlaps with the range in the claims. In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05 (I).

TeGrotenhuis fails to teach that the heat exchanger comprises the heat exchange fluid undergoing a phase change in the heat exchange channels.

Johnston, however, teaches a carrying out reactions in microchannels (para. 0064, 0079, claim 11) wherein the heat exchange fluids have a phase change in the heat exchanger (para. 0041).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the heat exchange fluids to have a phase change in the heat exchanger (para. 0041) in TeGrotenhuis in order to carry out chemical reactions in microchannels as taught by Johnston.

Regarding claim 2, 4, Johnston teaches that the number of catalyst zones is one or more, typically providing at least 3 beds in series (para. 0029).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide an additional catalyst in TeGrotenhuis because Johnston teaches that the number of catalyst zones is one or more, typically providing at least 3 beds in series (para. 0029).

Regarding claims 5,6, 8,12, TeGrotenhuis teaches that the heat-exchange channel is counter-current (page 15).

Regarding claim 11, TeGrotenhuis teaches that the heat-exchange channel is co-current (page 15).

Regarding claim 19, TeGrotenhuis teaches materials for the microchannel (page 21).

Regarding claim 20, 23, TeGrotenhuis teaches counter-current relationship of the fluid of microchannel with heat-exchange channel (page 15).

Regarding claim 24, TeGrotenhuis teaches a co-current relationship of the fluid of microchannel with heat-exchange channel (page 15).

Regarding claims 44-47, TeGrotenhuis teaches that the fins are coated with support foam that supports the catalyst coating (page 24).

Regarding claims 27 and 29, one of ordinary skill in the art would recognize that normal error rates in production of the microchannels and heat exchange channels would result in a slight variance of length the channels such that heat exchange channels would have a length that is different than the length the process microchannels.

Regarding claims 48 and 49, one of ordinary skill in the art would recognize that normal error rates in production of the fins would result in a slight variance of length and height of the fins such that at least one of the fins would have a length and/or height that is different than the length and/or height of the other fins.

Additionally, for claims 27,29,48,49, the claims recite certain dimensions being shorter than other dimensions. It appears that any variance would constitute a difference in dimension, i.e. the range would be anything less than exactly the same dimension. Because a dimension being slightly shorter than another dimension would be encompassed in this range, the prior art range is so close that one skilled in the art would have expected it to have the same properties. *Titanium Metals Corp. v. Banner,* 227 USPQ 773.

Regarding claim 55, TeGrotenhuis teaches that a method carried out is methanol synthesis. Additionally, it appears that carrying out this process would necessarily require an equilibrium approach substantially overlapping that of the claimed invention (more than 5%). In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05 (I).

Regarding the limitation in claim 78 of a first heat exchange fluid in first heat exchange channels and another heat exchange fluid flowing in another set of heat exchange channels wherein the first heat exchange fluid is the same as the another heat exchange fluid, the court held that mere duplication of parts has no patentable significance unless a new and unexpected result is produced. MPEP 2144.04 (VI) (B).

Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over TeGrotenhuis et al. (WO 03/078052) in view of Johnston (US 2002/0018739) and Foli (US 2005/0056409).

TeGrotenhuis teaches a method as described above in claim 20, but fails to teach that the heat exchange channel is made of steel, inter alia.

Foli, however, teaches carrying out a method using microchannels (para. 0002, Abstract) wherein a heat micro channel heat exchanger is made of steel (para. 0032).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the heat micro channel heat exchanger of TeGrotenhuis made of steel (para. 0032) in order to provide a known micro channel heat exchanger as taught by Foli.

Claims 52 and 53 are rejected under 35 U.S.C. 103(a) as being unpatentable over TeGrotenhuis et al. (WO 03/078052) in view of Johnston (US 2002/0018739) and Reyes (US 6726850).

TeGrotenhuis teaches the process as described above in claim 1.

TeGrotenhuis fails to teach the material of the support for the catalyst.

Regarding claims 52 and 53, Reyes teaches that alumina is a well known support for catalysts (col. 5).

Therefore, it would have been obvious to make the ribs of TeGrotenhuis out of alumina in order to provide a well known support for catalysts as taught by Reyes.

Claims 60, 61, 66, 67, 75, 76, 77 are rejected under 35 U.S.C. 103(a) as being unpatentable over TeGrotenhuis et al. (WO 03/078052) in view of Johnston (US 2002/0018739) and Tonkovich (US 6488838).

TeGrotenhuis '052 teaches a method as described above in claim 17, but fails to teach that pressure drop for the flow of reactant composition and product through the process microchannels is up to about 40 atm per meter of length of the process microchannels (claim 66), wherein a heat exchange fluid flows through the heat exchange channel, the pressure drop for the heat exchange fluid being up to about 50 atm per meter of length of the heat exchange channel (claim 67) or up to about 100 psi (claim 77), the total internal volume of the process microchannels is about 1 liter (claim 75), and that the process produces desired product at a rate of at least about 0.5 SLPM per liter of internal volume of the process microchannels in the microchannel reactor (claim 75).

Regarding claims 66 , 67, 77; Tonkovich teaches that the pressure drop through the microchannel unit was less than 0.6 psi (col. 4, lines 38-45; col. 5, lines 55-63).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the pressure drop through the microchannel unit less than 0.6 psi (col. 4, lines 38-45; col. 5, lines 55-63) in TeGrotenhuis in order to provide known reaction conditions as taught by Tonkovich.

It appears that the range of less than 0.6 psi overlaps with the claimed range in claims 66 and 67 of up to about 40 atmospheres per meter (claim 66) and up to about 50 atmospheres per meter (claim 67) and up to 100 psi (claim 77). In the case where

the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05 (I).

Additionally, it appears that Tonkovich teaches that the pressure drop of less than 0.6 psi applies to the entire microchannel unit including steam reforming and the heat exchanger in the absence of a showing to the contrary.

In the alternative, it would have been obvious to provide the pressure drop taught in Tonkovich for the heat exchange fluid as Tonkovich teaches that the pressure drop for other fluids (reactants) is used in other parts of the microchannel reactor in the absence of unexpected results.

Regarding claims 75, 76, and 77, Tonkovich teaches that the flow of the reactants is 2.81 SLPM and 1 SLPM and the residence time of the reactants is 9.2 milliseconds (col. 5, lines 50-60).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the flow of the reactants is 2.81 SLPM and 1 SLPM and the residence time of the reactants is 9.2 milliseconds in TeGrotenhuis in order to provide known reaction conditions as taught by Tonkovich.

It appears that the range the flow of the reactants is 2.81 SLPM and 1 SLPM and the residence time of the reactants is 9.2 milliseconds (col. 5, lines 50-60) are such that the products are produced to have an SLPM overlapping with the recited SLPM in claims 75, 76, and 77 for the products. In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05 (I).

Regarding claim 75, Tonkovich teaches that the microchannel reactor comprises 12 channels having dimensions of 2.79 cm * 2.54 cm * 750 microns (total volume is less than 0.007 liters, col. 5, lines 25-40).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide an internal volume of 0.007 liters (col. 5, lines 25-40) in TeGrotenhuis in order to provide known reaction conditions as taught by Tonkovich.

It appears that the volume taught by Tonkovich overlaps with the claimed range in claim 75. In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05 (I).

Regarding claims 60, 61, 76, Tonkovich teaches that the residence time of the reactants is 9.2 milliseconds (col. 5, lines 50-60).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the residence time of the reactants is 9.2 milliseconds (col. 5, lines 50-60) in TeGrotenhuis in order to provide known reaction conditions as taught by Tonkovich.

It appears that the residence time of 9.2 milliseconds (col. 5, lines 50-60) is close to the claimed range of 10-500 milliseconds (claims 60 and 61). The prior art range is so close that one skilled in the art would have expected it to have the same properties. *Titanium Metals Corp. v. Banner,* 227 USPQ 773.

It appears that the residence time of the reactants is 9.2 milliseconds (col. 5, lines 50-60) anticipates the range of the claimed residence time in claim 76. A specific

example in the prior art which is within a claimed range anticipates that range. MPEP 2131.03.

Claims 60, 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over TeGrotenhuis et al. (WO 03/078052) in view of Johnston (US 2002/0018739) and Ghosh (US 5961932).

TeGrotenhuis teaches a process as described above in claim 1.

TeGrotenhuis fails to teach the claimed contact time.

Ghosh teaches a method of carrying out chemical reactions in microreactors (col. 1, lines 14-31) wherein contact time in a microchannel for two reactants is 1 second for the purpose of allowing near complete mixing of the reactants (col. 1, line 65-col. 2, line 5).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the contact time in the microchannel for two reactants is 1 second in TeGrotenhuis in order to allow for near complete mixing of the reactants (col. 1, line 65-col. 2, line 5) as taught by Ghosh.

Regarding claims 60 and 61, one of ordinary skill would recognize that the contact time would be smaller for smaller channels. Therefore, smaller channels such as those taught by TeGrotenhuis (less than 0.5 mm, page 9) will result in contact times smaller than 1 second such that the range of contact times contemplated by the prior art overlaps with those of claims 60 and 61. In the case where the claimed ranges "overlap

or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. MPEP 2144.05 (I).

Claim 65 is rejected under 35 U.S.C. 103(a) as being unpatentable over TeGrotenhuis et al. (WO 03/078052) in view of Johnston (US 2002/0018739) and Hambitzer (US 5932791).

TeGrotenhuis teaches a method as described above in claim 1, but fails to teach that the pressure within the process microchannels is at least about 1 atm.

Hambitzer, however, teaches carrying out a method using microchannels (col. 8, lines 25-40) wherein the pressure of the method is not more than 225 bar (below 222 atm, claim 1; col. 8, lines 25-40).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide the pressure of the method in TeGrotenhuis not more than 225 bar (below 222 atm, claim 1; col. 8, lines 25-40) in order to carry out a known method in a microchannel reactor as taught by Hambitzer.

Claim 68 is rejected under 35 U.S.C. 103(a) as being unpatentable over TeGrotenhuis et al. (WO 03/078052) in view of Johnston (US 2002/0018739) and Brophy (US 7118920).

TeGrotenhuis teaches a method as described above in claim 1, but fails to teach that unreacted starting materials are recycled back to the inlet

Regarding claim 68, Brophy teaches conducting a method in a mircochannel apparatus (Abstract) wherein unreacted starting materials are recycled back to the inlet (col. 14, lines 5-15).

Therefore, it would have been obvious to one of ordinary skill in the art at the time applicant's invention was made to provide unreacted starting materials are recycled back to the inlet (col. 14, lines 5-15) in TeGrotenhuis in order to carry out chemical reactions in microreactors as taught by Brophy.

Allowable Subject Matter

Claims 73, 74, 80 are allowed.

The following is an examiner's statement of reasons for allowance: the prior art of record does not teach or suggest a process for generating either methanol (claim 73) or dimethyl ether (claims 74 and 80) in a microreactor wherein the product is formed in a, at least, two step process with the claimed equilibrium conversions in combination with the other limitations of claim 73 and claims 74 and 80, respectively.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PAUL WARTALOWICZ whose telephone number is

(571)272-5957. The examiner can normally be reached on 8:30-6 M-Th and 8:30-5 on Alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jessica L. Ward can be reached on (571) 272-1223. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Paul A Wartalowicz/
Primary Examiner, Art Unit 1735